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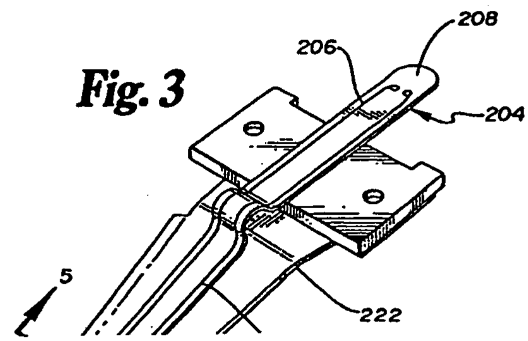
(54) Magnetic head arm assembly

(57) Arm 200 carrying a magnetic head 202 for cooperation with a magnetic disc is swingable about hinge zones 222 and electrical connections to head 202 are by conductors 206 embedded in a flexible strip 208 adhesively bonded to the suspension arm 200. This gives a reduction in height and damps the vibration of the arm.

Fig. 3



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The following corrections were allowed under Section 117 on 17 March 1988

Front page Heading (71) Applicant
for Hutchinson Technology
read Hutchinson Technology Inc

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Fig. 3

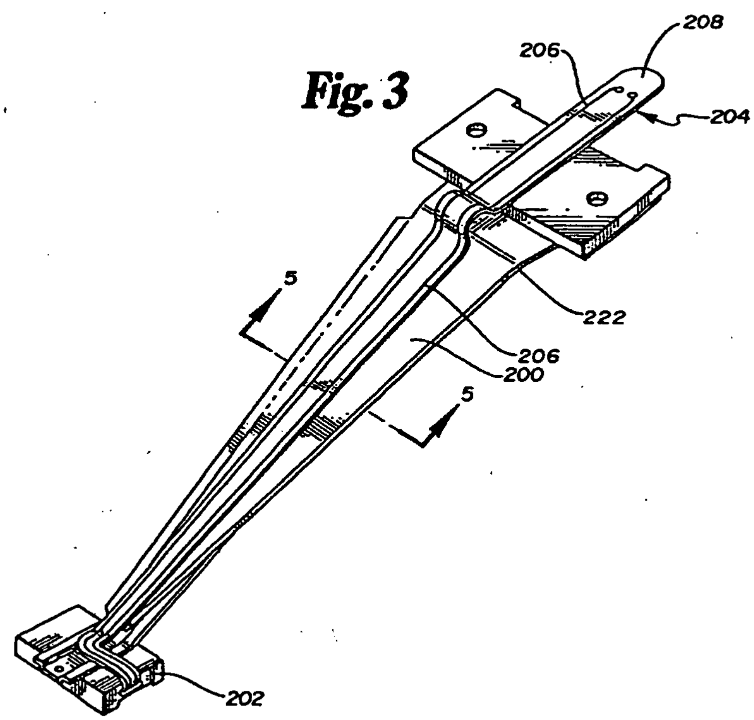

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Fig. 1

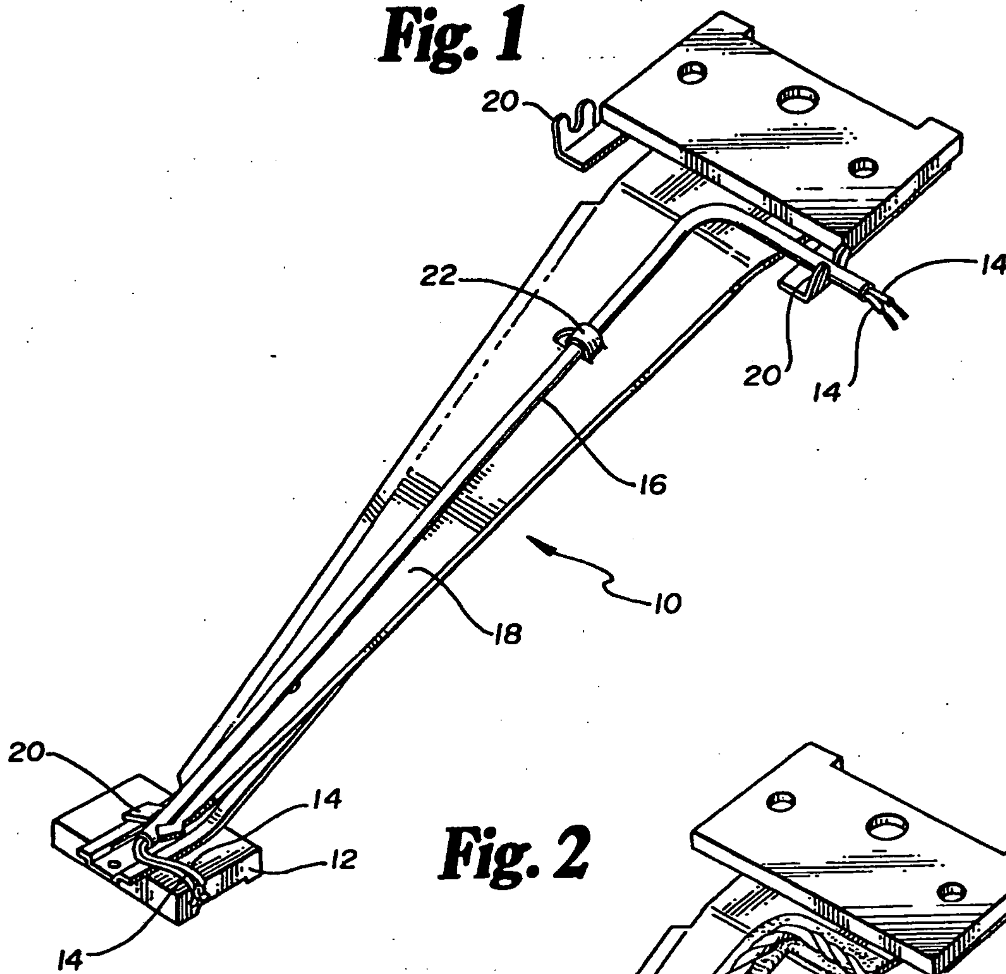

Fig. 2

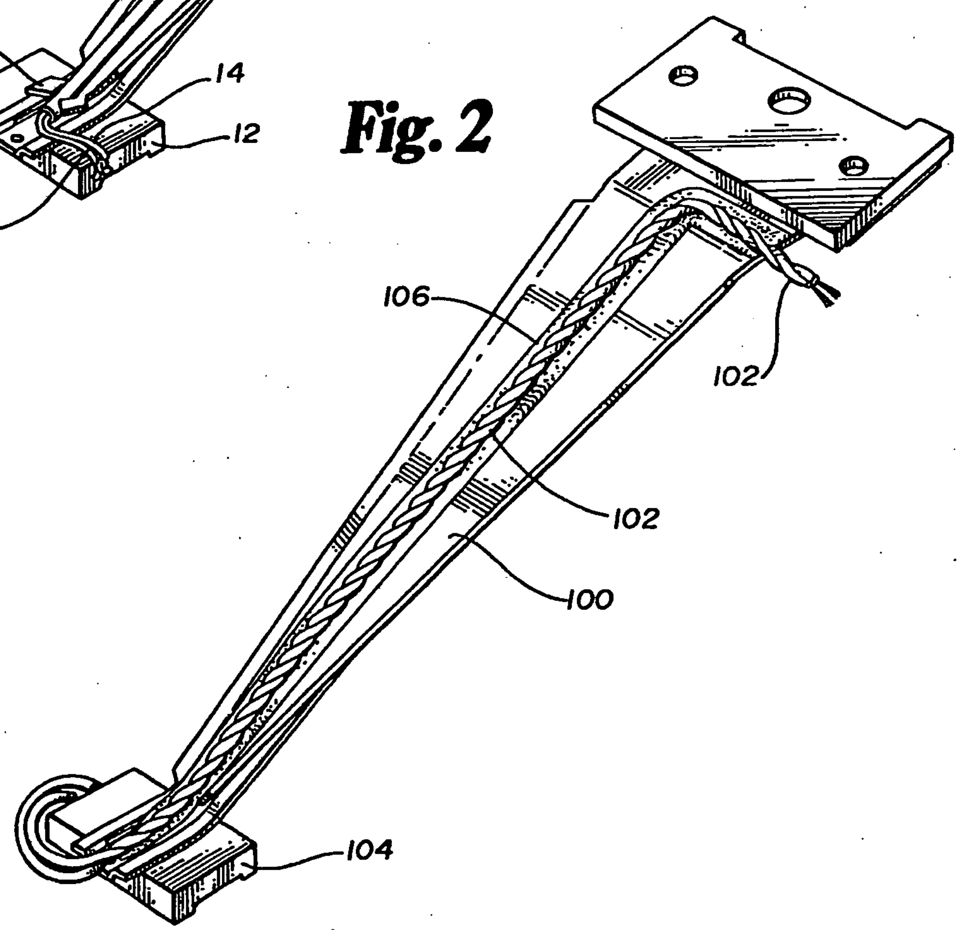

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Fig. 3

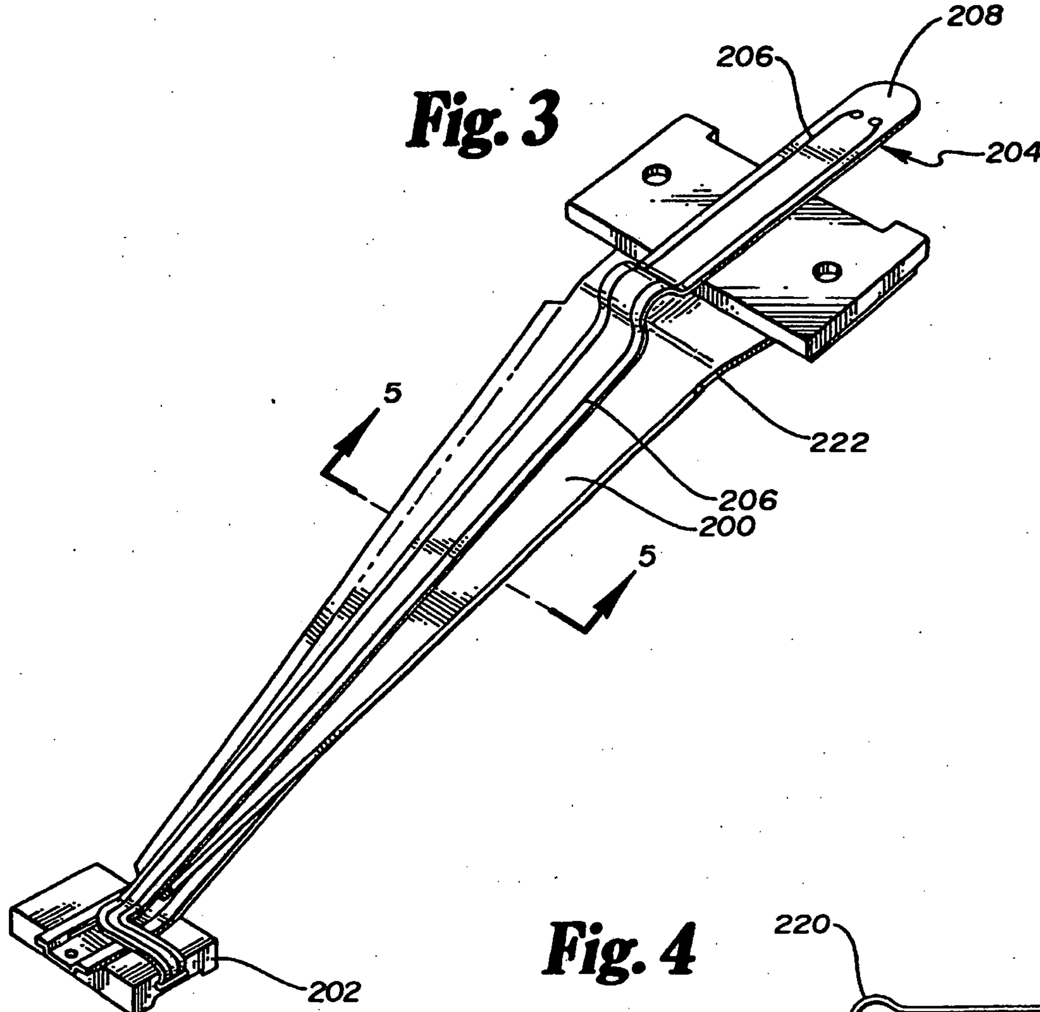


Fig. 4

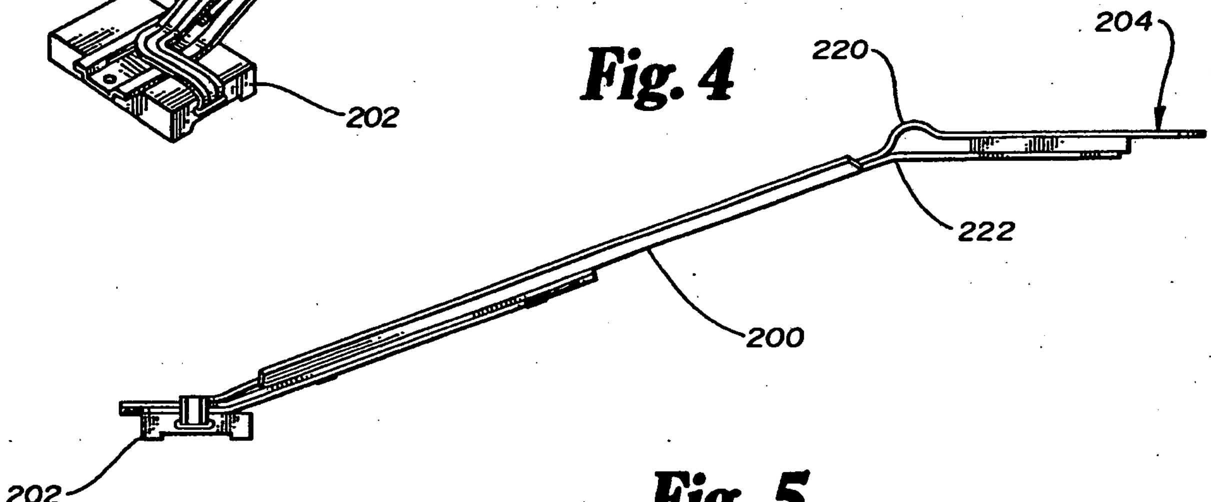
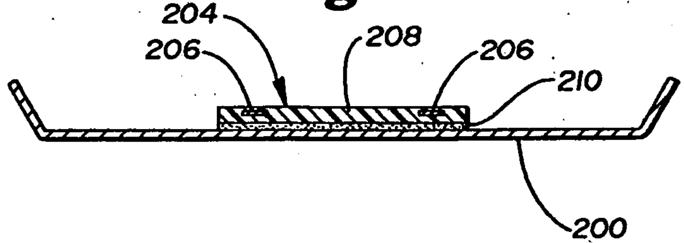


Fig. 5



SPECIFICATION

Magnetic head arm assembly

This invention relates to an improved magnetic head arm assenbly, and in a particular to an assembly having a flexible circuit connection between the head and arm cable.

Magnetic head arm assemblies, which are employed for radially accessing different data tracks on a rotating magnetic disk, are subject to different forces that will vary the spatial position of the head transducing gap relative to the data track that is being scanned. Undesirable radial and circumferential forces are experienced when heads start and stop in close proximity with the rotating disk. Frictional drag produces circumferential forces that effect head performance. Yaw moments appear usually as secondary effects.

In order to maintain reasonable read/write parameters the head distance is kept low, 15 microinches or less.

In U.S. Patent 3,931,641 to Watrous a magnetic head assembly is shown which provides flexibility of pitch around a longitudinal axis and roll around an orthogonal axis while maintaining stiffness and rigidity against radial, circumferential and yaw motions.

In U.S. Patent 4,208,684 to Janssen et al, a head mount is shown in which a pivoted rigid head support arm is controlled by an offset spring having an offset dampening and yieldably urging relationship to the rigid arm. This was to deal with the resiliency of the support arm which could result in vibrations of the arm which may be transmitted to the transducer.

Other attempts to allow desirable flexibility of movement for roll and pitch while still limiting radial, circumferential and yaw motion include U.S. Patent 4,167,765 to Watrous and 4,399,476 to King.

All magnetic head assemblies include a magnetic head at one end. The other end is attached to an actuator assembly. Electrical connections must be made between the head and the actuator assembly. Currently, individual fine wires are twisted and routed through a hollow, flexible tube which runs between the actuator assembly and the head. The tube is retained to the suspension arm by center tangs or pickle forks.

Such wire in tube connections make the suspension stiffer due to the tube presence. The tube distorts to fit into the pickle forks and center tang which are then pressed down to hold the tube. The fine wires within the 0.017 inch diameter (432 micron) tubing may be cut or otherwise damaged. The height of the pickle forks is also undesirable when stacking disks. Uniformity in operating parameters is difficult to achieve.

An object of this invention is to provide electrical connections between the actuator assembly and magnetic head without using wire in tube designs. Wire in tube designs are undesirable since the wire tends to break due to the excessive wire handling involved and crimping into the pickle forks and centered tang. Also, soldering of the fine wires to a termination pad is required. For shielding purposes the individual fine wires of the wire in tube design have been twisted. Such twisting is, of course, difficult to control, especially when wires are to be fed into a fine tube.

Another object of the invention is to eliminate the need for "pickle forks" or center tangs in load beams.

According to the present invention there is provided an arm assembly supporting a magnetic head and comprising a flat arm with a flexure zone at the end remote from the magnetic head and a plurality of insulated conductors extending along and adhesively secured to the arm.

In an embodiment to be described, a magnetic head assembly in accordance with this invention comprises a suspension system which includes a flexible circuit which is attached to the suspension by an adhesive. The ends of the flexible circuit have exposed copper traces which are bonded to the slider termination pads which, in turn, are secured to the head and to the termination pads of the arm which are secured to a mother cable. The exposed copper traces are connected to the head and termination pads by wire bonding, solder conductive epoxy or other suitable means for forming electrical connections between conductors.

The magnetic head assemblies of the invention which employ the flexible circuits are more reliable, have built in RF shielding which may be better than currently found in wire in tube constructions, and are less expensive to produce than the old magnetic head assemblies which employed wire in tube design. The magnetic head assemblies of the invention provide a dampening effect which may be tailor-made depending on the application. The adhesive bonding of the flexible circuit to the suspension can vary such that the portions of the flexible circuit are not in direct contact with a suspension assembly. A small loop may be added to the flexible circuit adjacent the pre-load radius zone of the suspension arm to minimize the effect of the flexible circuit on the gram load of the suspension arm. This loop can be designed to have a neutral effect on the spring rate.

Brief Description of the Drawings

A detailed description of the invention is hereafter described with specific reference being made to the drawing in which:

Figure 1 is a perspective view of a conventional suspension arm assembly;

Figure 2 is a perspective view of an embodiment of the invention utilizing twisted wires and adhesive;

Figure 3 is a perspective view of the preferred embodiment showing a suspension arm having a flexible circuit;

Figure 4 is a side elevational view of the arm of Figure 3 showing a loop in the flexible circuit; and

Figure 5 is a cross-sectional view of the arm of Figure 3 through line 5-5.

Detailed Description of the Invention

With reference to Figure 1 a conventional magnetic arm assembly 10 is shown. Assembly 10 includes a slider 12 which is connected to fine insulated wires 14 routed through a polytetrafluoroethylene tube 16. Tube 16 is held to arm 18 by pickle forks 20 and center tang 22. As noted previously, pickle forks and center tangs are highly undesirable since they may damage wires 14 and are relatively large which limits disk stacking.

Assembly 10 is also relatively difficult to make since tangs and forks are included. Assemblies such as shown in Figure 1 usually have undesirable resonance properties. The industry generally needs suspension arms which have maximum dampening properties in the 2000 Hertz at the first bending mode. Although the wire in tube designs tend to add a dampening effect, assemblies 10 as shown are difficult to manufacture which have proper resonating properties.

The invention as shown in Figures 2-5 provides suspension arms having very low profiles. Additionally, the invention provides dampening without damage to the conductors.

With reference to Figure 2, arm 100 is shown having several twisted wires 102 running between an actuator (not shown) and a thin film slider or head 104. Wires 102 are not held in position by pickle forks or centered tangs. Instead, twisted wires 102 are held to suspension arm 100 by a viscoelastic adhesive 106. The adhesives may include silicone rubbers, pressure sensitive adhesives and chemically curing polyurethanes such as the adhesive PR 1564 from Products Research and Chemical Corporation of Glendale, California. Kalex brand adhesives from HV Hordman, Company of Belleville, New Jersey are suitable elastomeric adhesives. Wires 102 may be adhered to arm 100 throughout the length of the arm or may be tacked on at spaced intervals by the adhesive. The bonding of the wires to the arm by the adhesive layer or spots eliminates the need for pickle forks and tangs and provides a dampening effect on the primary and secondary bending and torsional modes. The amplitude voltage required to attain resonance is also increased by the adhesive which bonds the wires in place.

The preferred form of the invention is shown in Figures 3-5. As in the embodiment of Figure 2, the inventive suspension arm 200 of Figures 3-5 eliminates the need for pickle forks and center tangs. Electrical connections between an arm assembly and slider head 202 are provided by a flexible circuit 204.

Flexible circuit 204 includes copper traces 206 which are insulated with a flexible film 208. Flexible film 208 may be formed from a polyimide such as Kapton V brand polyimide film or a polyester such as Mylar brand flexible polyester films both from E.I. DuPont de Nemours Company of Wilmington Delaware. The film layer is usually on the order of 1-3 mils (25-76 microns) in thickness.

Conductors 206 may be individual copper traces or may be formed by etching slots in a thin copper layer as is known in the art to provide separate conductive paths. As shown in Figure 5, the profile of the flexible circuit 204 is very low, much lower than possible with wire in tube designs. Stacking of the disks and heads with the suspension arms of the invention will utilize much less space.

Flexible circuit 204 is attached to the bare suspension by a viscoelastic adhesive 210. Generally, any adhesive which will bond to the flexible circuit and which after curing is at least somewhat elastic may be employed. Pressure sensitive adhesives, silicone rubbers and polyurethane adhesives are all suitable. The chemically curing polyurethanes produced by Products Research and Chemical Corporation of Glendale, California under its designation PR 1564 cures to a flexible, cold flow-resistant rubber which provides good adherence and dampening. Kalex brand elastomeric adhesives from HV Hardman Company of Belleville, New Jersey are also suitable for the purposes of this invention.

The adhesive 210 may be applied to the suspension arm along the entire length of the contact between the arm and the flexible circuit. Alternatively, the adhesive may be applied at spaced intervals so as to tack the flexible circuit to the suspension arm. Since the adhesive itself provides dampening, increased dampening will be provided if adhesive contracts more of the flexible circuit and arm surface.

The thickness of the adhesive layer 210 may vary depending on its adherence and dampening properties. Typically, a 1-6 mil (25-152 micron) layer 210 is formed between flexible circuit 204

and suspension arm.

The low profile of the suspension arms of the invention may be further reduced by modifying the basic suspension arm by reducing the rail height. Alternatively, the suspension arm could be formed as a laminate of multiple stiffening layers to control the pitch, roll and yaw as required. Since no pickle forks or center tangs are required with the invention, suspension arms no longer need to be formed from stamped pieces of metal.

As shown in Figure 3, a loop 220 may be formed in the flexible circuit 204 at the pre-load radius zone 222 of the suspension arm to minimize the effect of the flexible circuit on the gram load of the arm assembly. Another means to reduce the gram load influence of the flexible circuit is to provide a hole through the arm in the pre-load radius zone. The flexible circuit could then be routed on either or both sides of the opening between the head 202 and actuator.

Electrical connections between the conductive traces of flexible circuit and head or actuator may be made by thermocompression, ultrasonic welding, solder or conductive epoxies.

The following chart demonstrates the dampening achieved by the invention. The chart compares bending and torsional mode frequency and amplitude voltage when resonance is created in conventional suspension arms without wires to the suspension arm having a flexible film of Kapton V brand polyimide bonded thereto. A 2 mil (50 micron) polyimide layer and a 4 mil (102 micron) adhesive layer extended the length of the flex dampened suspension arm.

	Frequency-Hertz		Amplitude Voltage	
	Standard	Flex Dampened	Standard	Flex Dampened
1st Bending Mode	2160	1800	1.75	13.5
2nd Bending Mode	3440	----	42	----
1st Torsional Mode	2624	2360	0.7	2.0
2nd Torsional Mode	5730	5520	1.3	2.0

As shown above, the dampened suspension arms of the invention resonate below 2000 Hertz. The table also shows that the dampened parts require a higher input energy to achieve a given deflection amplitude. The wire adhered to suspension arms also exhibits good dampening over conventional wire in tube designs.

In considering this invention it must be remembered that the disclosure is illustrative only and that the scope of the invention is to be determined by the appended claims.

CLAIMS

1. An arm assembly supporting a magnetic head and comprising a flat arm with a flexure zone at the end remote from the magnetic head and a plurality of insulated conductors extending along and adhesively secured to the arm.

2. An arm assembly as claimed in claim 1 in which the conductors are embedded in a flexible flat strip.

3. A magnetic head arm assembly defining a longitudinal axis comprising:

a) a rigid arm section;

b) a spring element joined to said arm section and being formed with a stiffening deformation longitudinally and a rectangular type flexure at its free end;

c) a load beam positioned to said spring element; and

d) a plurality of insulated conductors for providing electrical connection from one end of the assembly to the opposite end of the assembly along the longitudinal axis, said insulated conductors being adhesively bonded to said load beam and said rigid arm section.

4. An arm assembly as claimed in claim 3 in which the conductors are embedded in a thin flexible insulating plastic film to form flexible circuit means and the said film is adhesively bonded to said load beam and said rigid arm section.

5. The assembly of claim 4 wherein said plastic film is selected from the group consisting of polyimides and polyesters.

6. The assembly of any of claims 1 to 5 wherein said adhesive is selected from the group consisting of polyurethanes and silicones.

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